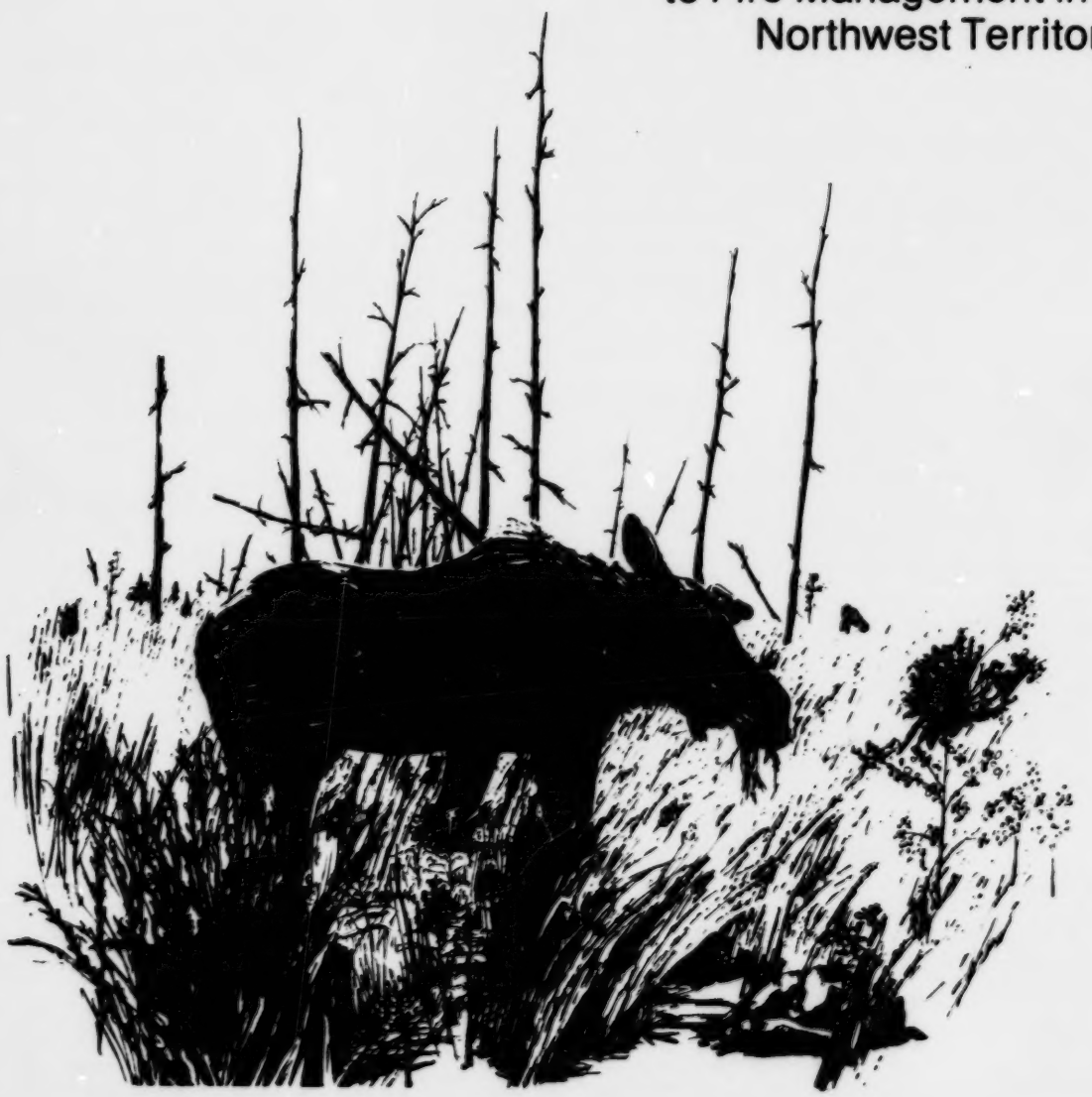
Fire Management

The Relationship of Fire and Wildlife to Fire Management in the Northwest Territories



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N.W.T. Wildlife Service
Government of the Northwest Territories

THE RELATIONSHIP OF FIRE AND WILDLIFE TO FIRE MANAGEMENT IN THE NORTHWEST TERRITORIES

BY

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for

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1. EXECUTIVE SUMMARY

Some relationships between naturally occurring wildfire and the ecosystem of the Boreal Forest are described. It is recognized that the Boreal Forest is a fire-dependent ecosystem whose components have all evolved in the presence of wildfire, perhaps even in response to wildfire.

Available information does not show that acreage burned each year (on an average) is increasing. In the Northwest Territories an insignificant proportion of the area burned is attributable to man-caused fires.

Managers must be concerned with populations of wildlife and ecosystem relationships rather than individual animals. While fire removes areas used by some individuals, the suppression of fire will also force individuals of another species out of an area. The natural regime of fire should be tampered with only if species or populations are in danger of being lost and lack of available habitat (because of fire losses or fire suppression) may be responsible for their decline.

Available data suggest that the above conditions do not now apply within the treed portion of the Northwest Territories.

Fire suppression has been a priority in the south for many years. Influences of suppression on the ecosystem are important. Risks of suppression are pointed out.

2. INTRODUCTION

2.1 Context

For centuries fire has been both an important tool and an implacable enemy of man. In North America, early European settlers caused and witnessed devastating fires which took many lives and flattened thousands of hectares of forest. Apart from destroying property, fire prevented the utilization by man of forest resources. Wildfire was an enemy. As the technological capability for preventing large burns grew, property was protected and catastrophic fires became uncommon events in southern areas.

It has been recognized recently that fire has an important role to play in ecosystems of North America. Rather than suppressing all fires, land management agencies are attempting to duplicate natural conditions, or to use fire to manipulate ecosystems and fulfill previously determined goals.

The policy of the Northwest Lands and Forests Branch of DIAND has been to fight fires in the Northwest Territories on a priority basis. Priority was based mainly on distance from settlements and transportation corridors. The underlying assumption was that controlling fire in all locations is worthwhile if funds and manpower are available.

The priority system provided a way for the Northwest Lands and Forests Service to distribute its effort over the

It is recommended that natural wildfire be allowed to burn in all wildlife habitats in the Northwest Territories until specific land use goals are established which require a change, or until acreage burned annually can be shown to exceed replacement by natural succession over large areas.

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The priority system provided a way for the Northwest Lands and Forests Service to distribute its effort over the

huge area it was asked to protect. However, serious problems occurred. As fires began in lower priority zones, Lands and Forests came under pressure from various interest groups to fight them. Ad hoc decision-making was time consuming, and advice from other agencies was inconsistent. Northwest Territories Lands and Forests was unable to schedule funds with a reasonable anticipation of demand. In 1978, the Northwest Territories Lands and Forests requested all agencies with an interest in lands to define and discuss their interest, with a view to developing a priority system for fire control based on ranking the various interests.

The Northwest Territories Wildlife Service was asked to provide input on priorities for fire management with respect to wildlife, hunting and trapping. Salix Enterprises Ltd. was asked to make recommendations to the Northwest Territories Wildlife Service regarding fire management in relation to wildlife.

2.2 The Approach

Several excellent research reports document the effects of fire on ecosystems under various conditions, and relate the results to habitat used by certain species or species groups of wildlife (Johnson and Rowe 1975, Rowe et al. 1975, Scotter 1964). A number of symposia have provided excellent overviews of approaches to fire management and research (most recently Dubé, 1978). Finally, the literature available on fire has been summarized in several publications.

The most useful for our purposes is Kelsall, Telfer and Wright's 1977 publication "The effects of fire on the ecology of the Boreal Forest, with particular reference to the Canadian north: a review and selected bibliography". Kelsall et al. (1977) is recommended highly to administrators who require a more thorough analysis of scientific material than is presented in this document. I suggest it be used as a companion to this report.

This report briefly summarizes material available elsewhere. It attempts to analyze why available information has not been used by managers in the Northwest Territories and elsewhere, and provides a system for implementing available information in management programs.

The task of making recommendations for an area the size of the treed portion of the Northwest Territories is large indeed. There are two basic ways of dealing with such a task. One is a mapping technique. Using available material on vegetation, one may categorize a series of habitat types. The areas covered by each category are outlined on maps of suitable scale. Then recommendations are made for each habitat type, and a patchwork of appropriate management responses results. The main disadvantage to such an approach is that it quickly becomes dated in an area of this size. In many areas, vegetation maps are 8 or 9 years old. Change has occurred since they were produced and considerable annual updating would be required to maintain them. In other areas many of the vegetative communities have never been

mapped. Assumptions would need to be made about vegetation zones or habitat types within large regions. In my view, a mapping technique of this kind would be of limited value.

The second approach, and the one I have chosen, rests on the development of certain criteria relating to fire management. I include recommendations for forest fire management in relation to wildlife for the entire Northwest Territories now. However, I include as well, criteria which may be used to respond to changing conditions in specific regions in the future. The criteria themselves may also be modified or added to if necessary.

2.3 The Assumptions

The Northwest Territories Wildlife Service and the contractor agreed that the following assumptions should be the basis for fire management in relation to wildlife and wildlife habitat. All are consistent with the published goals of the Northwest Territories Wildlife Service (Government of the Northwest Territories 1978).

The Boreal Forest is a fire-dependent biotype. Since the retreat of the glaciers, fire has been the key environmental factor initiating new successions, enhancing nutrient availability, and controlling species composition and age structure of forests. Fire is therefore the primary forest disturbance in the Northwest Territories. The effect of logging is minimal as relatively small areas contain commercial-sized timber.

Some areas are more susceptible to fire than others, depending on climatic conditions, quantity and quality of fuel, and lightning strike zones. On certain locations older stands develop; other areas are repeatedly burned.

A natural regime of fire in the past has produced a mosaic of habitats used by wildlife in the Northwest Territories. The variety of animal populations has enabled indigenous people to make their living from the land.

People in the Northwest Territories will continue to use wildlife resources. Demand will increase as the human population increases.

In some instances, to maintain favoured habitat for certain species, it may be advantageous to curtail wildfire, temporarily.

In some instances, to develop favoured habitat for certain species it may be advantageous to use prescribed burns.

3. COMMON PRECONCEPTIONS ABOUT FIRE

Among scientists who study fire, basic concepts of ecology related to fire and their relationship to wildlife have been understood for some time. Concepts which have been generally accepted have in many cases not been applied to management. I propose to examine some of the concepts basic to the ecology of fire and some of the common preconceptions relating to fire to orient you to the approach taken in later sections.

3.1 Fire Dependent Ecosystems and Succession

"The Boreal Forest is a fire-dependent ecosystem." This means fire has been the major disruptive force initiating new succession. Although this is a fairly easy concept to accept, we may fail to realize that it challenges our traditional idea of plant succession and climax vegetation.

Traditionally, we have seen secondary plant succession following fire as a series of progressive directional changes in species incidence and relative abundance. Eventually a self-perpetuating "climax" community develops on the site.

The idea of fire dependence challenges the concept of a directional sequence of plant communities culminating in the steady state or climax. Virgin forests grow in locations which have not suffered human disturbance.

Although we usually think of virgin forests as consisting of large trees which have survived since European settlement began, it is unrealistic to think of them as having been unaffected by fire. Virtually everywhere researchers have looked, evidence of previous fires has been found. Climax stands, as we have defined them, rarely or never exist in the Boreal Forest. When fire is excluded from an area a number of problems may develop, as described later.

3.2 "Climax Species" and Fire

"Barren-ground caribou are a species which is dependent on climax habitats and pine marten are found only in climax stands of trees." Those widely held opinions are often expressed in reference to a supposed incompatibility between fire and the continued viability of the species concerned. However, since true climax stands rarely or never exist, the phrase should be reworded. Both barren-ground caribou and pine marten have evolved and continued to exist in habitats manipulated by fire. They may more properly be called "late succession" species as discussed later.

3.3 European Settlement and Fire Incidence

Incidence of forest fire has generally been assumed to have increased since the advent of European exploration and settlement. The accepted corollaries of that statement are that man-caused fires are significantly adding to the acreage

burned each year, and that increasing industrial development and the people who accompany it will therefore cause even more fires.

The above assumption generally fails to analyze the effects of indigenous man on his habitat. Some northern tribes had a sophisticated understanding of some roles of fire in creating and maintaining certain types of habitat (Lewis 1977). Lewis (pers. comm.) contends that all North American Indians routinely used prescribed burns to modify their environment. Many early explorers recorded huge conflagrations resulting from Indian signal fires which got away or were left untended (Lutz 1956). There may also be little reason to assume that Indians who lived in mobile camps were more careful with campfires than Europeans. Before they had matches people may have been reluctant to put out household fires in case they might be needed again (Telfer pers. comm.). In any event, some fires undoubtedly got away during dry periods.

There are many stories of early prospectors starting fires to allow them better access to bedrock. The extent of those deliberate fires is unknown, as is the total incidence of man-caused fire - deliberate or accidental - in historical times.

Research which has been done in the Northwest Territories has not determined whether or not incidence of man-caused fire has increased since European occupation (Johnson and Rowe 1975). However, man-caused fire appears to

account for only about 1 to 3 percent of the area burned (Rowe et al. 1975).

There is no question that human activity has the potential to increase greatly in some parts of the Northwest Territories. There is also the accompanying potential for a great increase in "unnatural"fire as has occurred in parts of the south. However, at current levels of development, man-caused fire is adding an insignificant amount to the annual acreage burned. The habitats of the Northwest Territories still appear to be experiencing virtually natural levels of disturbance by fire.

3.4 Variability of Fire

Those of us who are not directly involved in fire suppression often make the assumption that fire is a single entity. We therefore find it easy to discuss the response of an area to fire without describing the percent area affected, the types of fuel present, the season, the size and intensity of the fire or other parameters. In specific situations, these factors modify the effects of the fire on soil and vegetation, and therefore may also influence the type and timing of regrowth on the area. Such factors must also be considered when recording results of prescribed burns.

4. FOREST FIRE AND MANAGEMENT IN THE NORTHWEST TERRITORIES

4.1 Definition

Fire management is defined as "conducting and designing fire programs to support the objectives sought in land use plans. It follows that as land management activities differ, fire management activities should be adjusted accordingly . . . . Fire management is the whole fire ball game beginning with fire as a part of land inventories, continuing on to fire prescriptions in land use plans and climaxing with expertly executed fire activities in the woods and on the range" (Ford-Robertson 1971). Rather than being seen as a destructive interference in the natural system, fire is perceived as a resource. With moisture, climate and soil, fire is responsible for the natural structure of the ecosystem on a given site.

The idea of controlling and regulating the role of fire in the ecosystem is a relatively recent one. The early concept which developed in the south and was brought to the Northwest Territories was that property needs to be protected from fire. The imperatives of protecting life and property became extended to transportation corridors and, on a priority system, to the entire Northwest Territories. The automatic response of many of us to fire has been that all lands which have any value must be protected from fire or this value will be lost. The possibility that protection may itself lead to losses has not been considered.

With the realization that North American ecosystems have been dependent upon fire to initiate new successions came an understanding of some of the beneficial roles of fire in natural ecosystems. Forest fire management is based on the premise that fire is a natural part of the ecosystem and that natural fires should be allowed as much as possible.

In certain national parks and other wilderness or semi-wilderness areas in the south, fire management programs are allowing wildfire to return to many areas. In other areas, prescribed burns are being introduced in an attempt to mimic the effects of wildfire.

4.2 Historical Data on Fire in the Northwest Territories

Fire in the Northwest Territories is the result, largely, of lightning strikes. The extent to which man-caused fire contributes to the acreage burned is not precisely known. Most recently (Johnson and Rowe 1975, Rowe et al. 1975) the available data have been interpreted as showing that 97 to 99 percent of the total burned area is the result of lightning-caused fires. Man-caused fires, although they can become large, occur most often near settlements and prompt spotting and action generally prevent them from becoming large.

Data on fire history in the Northwest Territories have been unreliable until relatively recently. An accurate record has not been maintained long enough for statistical comparisons to be made. However in all locations, the area burned over a reasonably long interval (at least 10 years)

is thought to be less than 1 percent per year (Kelsall et al. 1977, Scotter pers. comm., Thomas pers. comm.). This seems to pose no danger to northern ecosystems. However if the data set does not extend over a number of years and includes an extreme fire year, misleading figures may be produced. For our purposes, the number of fires per year is an almost meaningless statistic. The area burned is the important factor. Fire records should continue to be kept on a regular basis, with efforts being made to improve their accuracy, precision and reliability.

4.3 Effects of Fires on Northern Vegetation and Wildlife

No attempt is made here to duplicate the excellent review of Kelsall et al. (1977) or to describe the northern area. Rather, an overview of fire effects is given. The manager is encouraged to consider Kelsall et al. (1977) a companion document to this report. Those wishing more information are referred to references cited.

4.3.1 Vegetation

Most of the southern Northwest Territories is Boreal Forest. After disturbance by fire, secondary plant succession generally leads to a late succession structure of white spruce or black spruce. The most flammable forests in the Northwest Territories consist of coniferous trees - jackpine, white spruce and black spruce. Early succession stages of aspen and poplar are least flammable (Kelsall et al.

1977). However, vulnerability does not necessarily increase with age (Rowe and Scotter 1973), although older, drier upland sites are more often burned than are less dry communities in adjacent river valleys. However in the Cordilleran region, fire frequency is higher in the valleys and incidence generally decreases upslope (Rowe et al. 1975).

The many years of succession after fire in the Boreal Forest often begin with liverworts, mosses and other pioneer species, followed by the invasion of willow, aspen and birch which are eventually replaced by conifers (Kelsall et al. 1977). However, as Kelsall et al (1977) point out, the specific sequence differs from site to site depending on topography, soil moisture, severity of the fire, and available seed sources. An excellent summary of the literature relating to post-fire succession is given by Kelsall et al. The important feature to keep in mind for general management purposes is that there is no simple successional sequence following fire in the Northwest Territories.

Opinions differ about the effect of fire in the northern forest fringe. Strang (1973) stated that the exclusion of fire from northern subarctic forests in the lower Mackenzie Valley would allow the development of overage stands, with eventual elimination of trees. The moss-lichen stand which would remain is much like tundra. In contrast, recently burned areas vigorously regenerate new stands of trees as a response to improved nutrient levels.

Nichols (1976) observed that isolated dwarf spruce found in sheltered locations in the tundra reproduce vegetatively. They produce seed relatively rarely and seedlings are not found. Nichols regarded such spruce colonies as relics of consistently warmer past weather patterns. He further suggested that fitting modern climatic parameters to the present treeline fails because the modern treeline was established historically. Nichols suggested that past fluctuations in the forest-tundra boundary probably also account for open tundra patches isolated within northern woodlands. He stated that the width of the transitional forest fringe zone may give some idea of the extent of climatic shifts since glaciation. Although Nichols does not discuss effects of fire or clearing, his interpretations would mean that an area burned by a tree-killing fire would regenerate to trees only in locations where they successfully reproduce sexually and establish seedlings. Earlier authors (eg. Lutz 1956) commented that treeline areas may become tundra-like after fires because trees re-establish very slowly.

Wein (1976) investigated fires on the tundra. He found the frequency of fire in tundra regions to be low and the burned area small. Extent of individual fires depends on biomass and topography. Within a few years many burns re-vegetate to a point where they are not noticeable. Records of tundra fires are incomplete and their ecological significance is unknown, although generally considered low.

Kelsall et al. (1977) summarize current thinking with regard to fire and vegetation in the Boreal Forest (p.25):

> To summarize, forest succession has been intensively studied both in the northern Boreal Forest and elsewhere. Although there are general similarities, the mode of succession that can occur in each individual area depends on several factors that include the type of fire, the type of forest burned, presence or absence of permafrost, extent and quality of fuels on the forest floor, presence or absence of suitable seed for forest regeneration, topography and exposure. Many northern forests do not necessarily revert to deciduous growth following the burning of conifers. Black spruce in particular tends to be self-perpetuating and to dominate the northernmost Boreal Forest areas of Canada.
>
> It is probable that the northern coniferous forests are fire-dependent, in that fire provides for a dynamic ecosystem, much richer in plants and animals than it would be otherwise. The interspersion of forests of many different ages into a widespread mosaic is a natural feature. Where fire suppression is particularly efficient and long-lasting, the natural mosaic can be lost unless other factors replace fire as a disturbance factor. Forests that are protected with optimum efficiency will proceed to a relatively sterile and homogeneous climax of conifers or, where permafrost is near the surface, to a black spruce forest that may ultimately develop many sphagnum bogs. Examples of such climax associations are sufficiently rare that their composition and dynamics are not well known. They may "cycle" to young growth by wind, disease or insects in the absence of fire or logging.

4.3.2 Wildlife

Kelsall et al. (1977) provide an excellent summary of effects of fire on wildlife, so I will repeat only enough to provide the basis for the following discussion.

Many researchers have pointed out recently that if the Boreal Forest is a fire-dependent system, the animals which inhabit it have evolved in association with fire.

Fires are generally agreed to benefit populations of beaver and muskrat. Burning of marshes occupied by muskrats prevents them from being crowded out by grasses and other unfavoured plant species. Beaver depend for food on deciduous species characteristic of early stages in succession and may be absent from later stands composed entirely of coniferous forests.

Red squirrels inhabit late succession forest stands. Pine marten are also a late succession species and, although not entirely dependent on them, often prey heavily on red squirrels (Kelsall et al. 1977). Ground fires which do not destroy the forest canopy may result in improved conditions for small mammals and therefore an increased food supply for marten. Fire which removes the forest undoubtedly results in losses of marten. However, it is probably only those animals living in the fire area which are lost and areas unburned will retain marten. Whole populations do not seem to be at risk from uncontrolled fire at current levels. Although marten are known to occur in areas which are trapped, they are undoubtedly also found in relatively remote areas of suitable habitat. Danger to marten populations from a natural fire regime is relatively minor.

Hares do best in early succession stages following fire. Lynx thrive wherever hares are plentiful. Other furbearing predators such as coloured fox and weasels probably do best when a mixture of habitat types provides optimum habitat for a mixture of prey species.

Moose occur throughout the Boreal Forest. Few are found in mature coniferous forests, but they are often plentiful in areas with large amounts of aspen, birch and willow. Several authors believe that moose numbers fluctuate largely in accordance with the amount of habitat made available by fire. Optimum habitat generally occurs between 11 and 30 years after burning (Kelsall et al. 1977). Some moose populations may be suffering habitat losses because of fire control activities near settlements or in the Mackenzie Valley.

Kelsall et al. (1977) discuss barren-ground caribou at some length. There is still controversy over the extent to which fire has negative consequences for caribou habitat and the length of time it takes habitat to recover. Johnson and Rowe (1975), Rowe et al. (1975), Kershaw and Rouse (1976), Scotter (1964, 1967, 1970, 1972), Rowe and Scotter (1973), Miller (1976), and Bergerud (1974, 1978) have all contributed to the discussion.

Although fire has definite implications for caribou habitat, caribou populations appear, presently at least, to be largely uninfluenced by lack of available habitat. D. Thomas of the Canadian Wildlife Service and R. Robertson of the Manitoba Department of Fish and Wildlife are currently (early 1979) re-examining and re-assessing older data on the relationship between barren-ground caribou and wildfire. Their preliminary conclusion is that there is no reason now to limit fire for the supposed benefit of caribou populations (Thomas pers. comm.). They will be recommending that certain research be

undertaken to investigate some aspects of the relationship. I suggest that their review be carefully read by senior administrators who are concerned about fire/caribou relationships.

The Kaminuriak population of barren-ground caribou is suffering annual mortality in excess of recruitment (Simmons et al. 1979). At the same time that the herd is experiencing a precipitous decline, it has apparently abandoned some of its southern ranges. Some investigators in Manitoba (Robertson 1977) suggest that severe fires in 1973 may have deflected the movements of caribou. There are no data which test this hypothesis. Barren-ground caribou populations which are decreasing in number can be expected to abandon parts of their ranges regardless of the incidence of fire. Acreage burned annually is apparently not large enough to influence population size. Range relationships of large, expanding populations of barren-ground caribou (eg. the George River herd) require investigation to test the hypothesis that lack of range may contribute to a decline in caribou numbers (Scotter pers. comm.).

Woodland caribou are found largely in coniferous forests in the Northwest Territories (Kelsall et al. 1977) generally south of barren-ground caribou winter ranges and in Cordilleran regions. When their range burns it is often, but not always, quickly re-occupied by moose.

Muskox are primarily tundra animals. There is no reason to assume their habitat to be threatened by fires.

Bison occur in relatively small and restricted habitats in the Northwest Territories. They feed primarily on slough sedge and reedgrass, and tend not to browse. Wet meadows are primarily favoured (Reynolds 1970, Reynolds et al. 1978). Open grass/sedgelands used by bison were probably developed and maintained by a combination of fire and flooding or by fire alone. In the absence of those disturbances willow and other woody species will invade the open areas. Flooding and fire or repeated fire are required to remove them. A single fire will often not be adequate to cause willow to be replaced by grasses or sedges. Willows will send out suckers after fire, and another fire or severe browsing pressure may be required to kill them.

Wood bison in the Mackenzie Bison Sanctuary now number 560. The last census of the Slave River wood/plains bison herd counted only 551 animals (Stephenson pers. comm.). This population is in a serious decline attributed to mortality (from wolves and hunting) in excess of recruitment (Calef pers. comm.). The carrying capacity of available bison habitat is not known. Although estimates of carrying capacity of the bison prairies far exceed the numbers of animals present (Reynolds 1976), winter and summer habitat for both groups will decline in area and quality if fire is suppressed on their ranges (Jalkotzy and Van Camp 1978).

Kelsall et al. (1977) record that fires are generally believed to benefit black bears. Old burns provide excellent crops of berries which are heavily used during fall. For the

same reason, fires would probably benefit grizzly bears.

Peregrine falcons, gyrfalcons, bald eagles, osprey and other raptors return year after year to traditional nesting sites. Fires may change surrounding habitat or even burn the nest and nest site. However, Fyfe (pers. comm.) stated that fires in the vicinity of nest sites probably have largely beneficial side effects by allowing increases in prey populations. Many birds which nest in dead trees may take advantage of snags remaining after a fire has passed through an area.

The above discussion has only outlined the effect of fire in general on the habitats of certain economically important species of animals in the Northwest Territories. More specifically it has mentioned the food requirements of these species with reference to the generalized succession sequence outlined earlier. This paper does not provide the reader with a predictive model of the effects of fire on all specific sites in the Northwest Territories. A site which burns and immediately regenerates to jackpine or spruce will provide little benefit to moose, for instance.

From the brief descriptions above it should be evident that habitats which are unsuitable for one furbearer or ungulate will probably be used by another - with the possible exception of the barren-ground caribou winter ranges. Natural fire has produced a mosaic of habitat which we must regard as optimum until we define objectives and land use values which the natural system fails to meet. This we are not yet required to do in the Northwest Territories. On an ecosystem basis, there is no justification for

excluding fire in the Northwest Territories to benefit wildlife.

If habitats are manipulated, either by artificially introducing fire or artificially excluding it, much more specific detailed data are required than if they are left to natural forces.

Available habitat is obviously the ultimate factor limiting the size of all populations. When introducing or excluding fire in an attempt to influence the size of a population it must be clear ahead of time that lack of suitable habitat is limiting the population or the response will not be the anticipated one. Although researchers generally agree about factors limiting a given population, substantiating scientific data may be hard to find.

Even determining how many animals a given area should be able to support is not a straight-forward problem. Traditional ideas of carrying capacity are being challenged by the discovery that the amount of browse available on a given bush from one year to the next may vary by a factor of 2 (Telfer pers. comm.). Determination of the carrying capacity of barren-ground caribou winter range is complicated by factors such as availability of forage related to snow conditions, previous cratering by caribou in the area, access to range because of recent fires, and general forage conditions in the region chosen by caribou in a given year. These two examples are included only to indicate some of the difficulties of determining capability of an area to support animals.

4.4 Prescribed Burns

Prescribed burning is "controlled application of fire to wildland fuels in either their natural or modified state, under such conditions of weather, fuel moisture, soil moisture, etc. as allow the fire to be confined to a pre-determined area and at the same time to produce the intensity of heat and rate of spread required to further certain planned objectives of silviculture, wildlife management, grazing, fire-hazard reduction, etc." (Aldrich 1974).

Prescribed burns are an attempt usually to either a) duplicate the results of natural fire, or b) produce a specific desired vegetation type in response to fire.

Barrows (1974) stated that the following conditions should apply before prescribed burns are attempted:

1) a plan should be prepared in advance specifying the area to be covered, the weather required, ignition of the fire, expected fire behaviour, duration and intensity, and control measures;
2) the burn and its management should result in net benefit to environmental quality; and
3) the burn and its management should not degrade watersheds, threaten public safety, damage property or infringe on social and economic values.

Prescribed burns are generally undertaken either in spring or fall. The choice of season is usually based on having dry enough fuel to get the desired intensity of burn at the same time as high relative humidity and cool weather to make control relatively easy. Sites of spring burns often

produce usable forage in the summer immediately following the fire. Locations of fall burns are barren until the following spring.

The costs of doing proper prescribed burns in the Northwest Territories will be large. Prescribed burns should be used only in relatively discrete areas of important habitat for a given species. As a management tool, they should be used only when natural fire is not producing the desired result or where for some reason natural fire cannot be tolerated.

If prescribed burning is done in the Northwest Territories a burning plan should be prepared ahead of time. An attempt should be made to document the pre-burn situation. The post-burn situation should be analyzed in terms of its success in producing the desired objective. Characteristics of the fire itself and season of the burn may be important to the objective and should also be recorded.

4.5 Risks of Fire Suppression

4.5.1 In the Boreal Forest, fire is a major factor in energy flow and nutrient recycling. Fire frequency and intensity influence the precise timing and pathways involved. When fire is suppressed, the large biomass of trees and detritus may effectively block energy flow and recycling of nutrients. In the Boreal Forest, burning may be necessary to recycle nutrients (Telfer pers. comm.).

4.5.2 As more of the nutrients become tied up in the standing crop, productivity of an area may decrease.

4.5.3 Slow rates of decomposition in the north result in a buildup of detritus in older stands. This, plus the larger standing crop, means the fuel load becomes greater and fires which do ignite may be larger or more intense than natural fires.

4.5.4 The natural wildfire regime controls the total mosaic of successional stages and stand ages. Fire, therefore, prevents the entire system from developing to a species-poor late succession stage. On a large scale, intensity, size, and return interval of fire determine the diversity of plant and animal communities. The removal of fire and increased acreage in older forests will ultimately harm populations of wildlife which depend on plant associations developing soon after fire.

4.5.5 Infestations of insects and parasites may become more common and cover wider areas when fire is excluded from a system. Under natural conditions, stands susceptible to such infestations would be relatively small and fire would destroy both the pest and the susceptible stand.

4.5.6 As forests age and become decadent deadfall increases. Deadfall is also produced by deaths from insect outbreaks and parasites. This increases the hazard of a large, intense fire if the area ignites.

4.5.7 Fire suppression may have mixed effects on permafrost levels. It has been well documented that fire in the Boreal Forest may increase the depth of the active layer with the result that slumping or sliding may occur. Periodic fire in productive alluvial white spruce forests prevents perma-

frost from encroaching into the white spruce root system and causing a gradual replacement by black spruce.

4.5.8 The overall system produced by natural fire tends to be more stable than the forest which results from effective fire suppression. Accumulation of dry material in areas where fire has been excluded could result in later uncontrollable, very large scale, intense fires. Regeneration might then proceed abnormally because of the size of the burn and lack of seed sources. A large aged forest would also be more susceptible to blowdown and parasites and would support less diverse animal populations (Wright and Heinselman 1973).

4.5.9 Evolutionary implications and the role of fire in natural systems are not understood. Fire and climate have been the major factors influencing evolution in the northern forests since the glacial retreat. Howe (1974) expressed concern about genetic consequences of removal of fire, suggesting that reductions in mutation and gene exchange may occur, as well as reduced random genetic drift. Fire removal would have unknown consequences for selection. Fire manipulation, then could have serious evolutionary consequences (Howe 1974).

4.5.10 Effective fire suppression, if implemented over a large area of the Northwest Territories, would be an inadvertent ecological experiment on a scale unprecendented in North America. The negative effects of excluding fire from relatively small areas such as national parks have been well documented in the south, and fire is being introduced or

allowed to burn in some areas in an attempt to re-introduce natural disturbances in the ecosystem. Many southern areas experience ecosystem manipulation that is relatively rare in the north. Agriculture, clearing, cattle grazing, and forestry activities are all pursuits of man that occur in southern regions which are protected from fire. Even though these all have the effect of retarding or reversing plant succession, many areas outside parks are also disadvantaged by lack of fire.

If fire were effectively removed from even a large part of the treed portion of the Northwest Territories for 50 or 100 years the implications could be expected to be great though also mostly unknown. Some of the known implications are described earlier, but it must be emphasized that this is an incomplete list.

Fifty or 100 years seems like a long time. Surely decisions regarding fire can be postponed - we can implement politically expedient solutions now and let others deal with the later implications. However, those implications begin when the first area which would have burned naturally is prevented from doing so.

On an ecosystem scale, we have the opportunity to pass to future generations a valuable natural system in which fire has a place, or a monoculture which must be protected and manipulated carefully to prevent large scale devastating fires.

4.6 Research Needs

Kelsall et al. (1977) listed current research requirements. In part they said (p. 46):

> Studies (beyond those cited) of the impacts of fire on permafrost areas having varied site characteristics are required. Such studies should concern the chemical and physical properties and moisture relationships of soils as affected by burning, the quantification of the extent of thawing caused by fire, and the net result of all effects on site productivity.
>
> Estimates are required of the rate of burning in key areas in the past; these estimates would be based on studies of historical records and on analysis of existing vegetation and of pollen and charcoal accumulation. A knowledge of past situations will put present conditions in correct perspective. Rowe et al. (1975) have suggested that current rates of burning could be monitored by satellite imagery.

Their detailed recommendations followed.

Thomas and Robertson will also undoubtedly make further suggestions about research requirements relating the relationship between barren-ground caribou and fire. They may also discuss ways of determining when or how barren-ground caribou populations are limited by habitat. Research on the barrier effect of burns is recommended (Scotter pers. comm.). Scotter (pers. comm.) suggested that range studies on the George River herd in Ungava should begin immediately to investigate relationships between large, expanding populations of caribou and their ranges. Although this herd does not range within the Northwest Territories, data from such studies could provide valuable insight into the dynamics of caribou populations.

It seems important to determine whether or not

forest-tundra areas will regenerate following a tree-killing fire.

The excellent work being done by Rowe and co-workers and a few others in the Boreal Forest of the Northwest Territories should also continue.

Increasing the store of knowledge related to fire ecology at the present time seems less important than applying available knowledge. If recommendations outlined in this report are followed, other gaps will become apparent to managers. Additional research can then be funded to close those gaps.

Management implications of all research should be phased into the overall fire management scheme in the Northwest Territories.

5. RECOMMENDATIONS

5.1 Criteria for Decision-Making

The basic criteria for fire management/wildlife relationships are (see Appendix 6.1 for development of criteria into a decision-making tool):

1) Natural conditions will be allowed to control habitats and populations within the Northwest Territories. Because of the importance of fire to the general ecology of the Boreal Forest, fires will normally be allowed to burn.

2) If it can be shown that the acreage burned annually is increasing over a significant time period and that a significant portion of the acreage burned is the result of man-caused fires, consideration may be given to controlling some fires.

3) Fire suppression will not be considered if no species or populations within a given area are endangered.

4) If an endangered species or a non-harvestable population of restricted habitat appears to be limited by available habitat and that habitat would be improved either by excluding fire or prescribing burns, those management measures will be considered.

5) Species which are widespread in the Northwest Territories in suitable areas will be subject to natural regulation in response to fire.

5.2 Recommendations

1) Natural wildfire should not now be curtailed for the benefit of wildlife anywhere in the Northwest Territories. This statement should be continually re-assessed in the light of incoming data in combination with the above criteria.
2) Prescribed burns should be considered for the bison range to improve quality of habitat on areas which have been protected from fire in the past or must for some reason be protected in the future. Spring burns on or around key winter ranges should be considered. Where natural fire fails to remove undesirable species such as willows, additional prescribed burns should be considered (Appendix 6.2).
3) Prescribed burns should be considered for areas within fire control zones which protect other resources if they are requested by people using the area (eg. moose habitat in the Mackenzie Valley).
4) Fire occurrence, size, cause, type and intensity statistics should continue to be collected.
5) The Northwest Territories Wildlife Service should maintain current information on fire statistics in its own files for its use and the use of hunters' and trappers' organizations.
6) The Northwest Territories Wildlife Service should work with the trappers' organizations to develop a flexible,

fair system of trapline allocation:

a. to avoid large individual losses in the event of fire, and

b. to allow fire to play its natural role in the area (Appendix 6.2).

7) The Northwest Territories Wildlife Service should consider fire ecology to be an important part of its continuing education program (Appendix 6.2).

Appendix 6.1

DEVELOPMENT OF FOREST FIRE MANAGEMENT POLICY IN RELATION TO WILDLIFE: a key

The following key should be worked through when making decisions to change fire management policy. It presents the main criteria used in this paper in a decision-making format. It will not make sense unless it is used as a key. Single insertions may seem to be inconsistent if taken out of context.

The Northwest Territories Wildlife Service may wish to insert relative values in parts of the key (in blank brackets). These values would be expected to be highest at the beginning of the key and lowest at the end.

1. a) Area supports endangered species during all or part of the year 2
   b) Area supports non-harvestable populations during all or part of the year 3
   c) Area supports only harvestable species or populations 4
2. If a species is considered to be endangered for any reason, it deserves special protection. This will not necessarily involve the fighting of forest fire. It may include prescribed burns for habitat improvement of small areas, protection from fire for large areas of

habitat, protection for specific sites, or no protection at all.

a) If an endangered species depends on habitat produced or maintained by fire, prescribed burns will be considered and natural wildfire will not normally be fought. ( ) 5

b) If an endangered species depends on late succession vegetation, protection of the habitat from fire will be considered. ( ) 5

c) If an endangered species has specific traditional homesite locations which will lose their value in the event of fire, consideration will be given to protecting these sites from fire. ( ) 5

3. Populations which are non-harvestable because of low numbers should be protected if they are important to subsistence users or are of special interest for other reasons. Their priority will be lower than that for endangered species.

a) If the population depends on habitat produced or maintained by fire, PRESCRIBED BURNS WILL BE CONSIDERED AND NATURAL WILDFIRE WILL NOT NORMALLY BE FOUGHT. ( ) 5

b) If the population depends on late succession vegetation stands, PROTECTION OF THE AREA FROM FIRE WILL BE CONSIDERED. ( ) 5

c) If the population has specific traditional homesites, consideration will be given to protecting known sites

from fire if it would damage them. ( ) 5

4. If no species or populations using a given area are endangered, no prescribed burning will be done and no natural fires will be fought. LET BURN POLICY.

5. After the criterion of danger to the population or species has been met, habitat consideration will be evoked in the decision of whether or not to fight fire or to prescribe burns.

   a) Non-harvestable population numbers appear to be limited by lack of available habitat. ( ) 7

   b) Habitat is presently not a limiting factor. ( ) . . 6

6. a) Quantity or quality of a habitat restricted in area can be shown to be declining over a reasonably long (e.g.10 year) period, and desirable change would be produced by fire. ( ) 9

   b) Quantity or quality of a habitat restricted in area can be shown to be declining over a reasonably long (e.g. 10 year) period and undesirable change would be produced by fire. ( ) 8

   c) Habitat is not declining in quality or quantity for favoured species. IMPLEMENT LET BURN POLICY.

7. a) Non-harvestable population will increase if fire is prevented. CONSIDER FIRE CONTROL.

   b) Non-harvestable population will increase if fire is allowed on the area 9

8. The incidence of fire is not an important statistic with regard to wildlife. More important are average acreages burned annually and possibly sizes of areas burned in large fires.

   a) Acreage burned by either natural or man-caused fire can be shown to be increasing over a long term. Acreage of undesirable habitat can be shown, by statistically satisfactory figures, to be increasing over the long term. FIRE CONTROL MAY BE CONSIDERED IF ECONOMIC OR OTHER CONDITIONS WARRANT IT.

   b) Acreage burned annually does not appear to be increasing. Habitat destruction, if it is occurring, is the result of other forces which must be investigated before decisions are made to control fire as a counter balancing force. CONTINUE LET BURN POLICY.

9. a) Wildfire can be allowed to burn in the area. IMPLEMENT LET BURN POLICY.

   b) Wildfire cannot be allowed to burn in the area for reasons not associated with wildlife. CONSIDER PRESCRIBED BURNS.

   c) Repeated fires burning at certain seasons or intense small fires will result in most favourable habitat. CONSIDER PRESCRIBED BURNS.

Appendix 6.2

HUNTING AND TRAPPING CONSIDERATIONS

Although values relating to exploitation of wildlife resources are outside the terms of reference of the contract and outside my area of expertise, I offer the following observations in hopes that they may be of some value.

Trappers and trappers' organizations in the Northwest Territories are concerned about wildfire and have petitioned government agencies to protect their property - cabins, traps, etc. - and their accustomed trapping locations from fire.

Although their approach is of course understandable, it is not compatible with long term good resource management. In the short term, cabins would be saved. Individuals would be spared losses in trapping revenue which would result if an active area were burned and the individual trapper unable or unwilling to relocate.

If a trapper gains his primary trapping income from marten, and his usual area burns, he will feel he has suffered certain losses. However, the characteristics of the fire may affect the severity of those losses. On the Pre-Cambrian Shield, in particular, it is not uncommon that within the perimeter of a fire, only 50 percent of the area is burned. Fire type and intensity and kind of material

burned, as well as topography and weather during the burn all affect the area burned within the fire zone. Therefore the extent of damage to the trapper and the period of time that the trapper will suffer vary. Three or 4 years after the fire, an area which has been only half burned may be excellent lynx habitat. All species taken for food or fur with the possible exception of marten thrive in some combination of habitats including early successional stages.

Little is known specifically about marten habitat requirements, particularly in the Northwest Territories. However, trappers whose usual lines have been burned extensively would undoubtedly find themselves unable to take as many marten as they could before a fire.

Traditional relationships of the Dene and Inuit to fire are not known in detail. Athapascan Indians in northern Alberta have used fire for centuries to modify their environment (Lewis 1977). Among the reasons for burning are the manipulation of habitat in favour of certain species or to make travel for hunting and trapping easier. Lewis (pers. comm.) contends that all the northern Indians undoubtedly knew and understood basic fire ecology and used controlled burns to manipulate habitat. Uncontrolled wildfire was a danger because of its unpredictable nature and because of primitive transportation methods which had to be used to avoid it.

Traditional hunting societies of the Boreal Forest obviously functioned well in an environment largely molded by fire.

If one hunting area was unusable for a few years, both they and the game moved elsewhere. Once the fur trade began, fire may have become a larger problem, but people apparently still hunted and trapped in groups across lands to which the group had ties.

The current situation is different. In parts of the Northwest Territories, individuals have registered traplines on which they have an exclusive right to harvest furbearers. One or more cabins may be used during the trapping season. In other locations communities have group trapping areas. However, within those, I understand, individuals often are agreed to have a priority "right" to a certain area.

This may pose some difficulties regarding the fire management program I have outlined. Even more difficulty may become apparent when the interests of other agencies are inserted into the program. Probably some trapping areas will have protection from wildfire and others will not.

The trapper is naturally anxious to pressure government agencies to protect his short term interest. However, since fire has always been a part of the northern ecosystem, he may not realize that effective protection will jeopardize his long term interest.

The inflexibility of a system in which traplines are registered to individuals may make fire management for wildlife difficult. If trappers demand fire protection for their individual properties on the same basis as do southern

landowners, the situation could become imposible. However, if a more flexible arrangement of trapline allocation can be worked out with the co-operation of trappers' associations, there could be major long term benefits.

Fire affects less than 1 percent of the land area in a given year and trappers' associations should be encouraged to work with the Northwest Territories Wildlife Service to co-ordinate their activities to allow for the natural low level of fire. The problems will undoubtedly be difficult to resolve, and the trappers' groups should be invited to help produce workable solutions which will also result in good resource management. If all cabins are eventually owned by the trapping association and used by the individual working the line, replacement of burned property might be more readily arranged. Rather than spending far more money protecting a cabin than the cabin is worth in an area which subsequently may be unused for 5 years, funds could be made available to the trappers' association to construct another cabin in another area where the dispossessed trapper would be able to go. Problems exist with this approach, of course. Relative values of different trapping areas, distance from town and other factors all influence revenue earned by a trapper. However, the same individual could be given the opportunity of returning to and trapping on the burned area whenever he wishes.

Sites for new cabins could be chosen to minimize risks of loss from fire. Locations on the east side of lakes,

for instance, should be less vulnerable. Prescribed burning to remove flammable material in the immediate vicinity of the cabin could be used by the trapper to reduce the possibilities of losses (Telfer pers. comm.). Trappers may also wish to consider the possibility of developing a fire insurance scheme similar to crop insurance programs available to farmers (Kelsall pers. comm.).

Two alternatives to the above approach pose more problems. The first, that of allowing wildfires to burn and maintaining the present system of allocating trapping areas, may result in large losses to individuals, will result in ad hoc solutions to individual losses and will probably encourage continual pressure to fight fires. The consequences of the second, that of maintaining the present system and fighting wildfire as recommended by the trappers are outlined above. Neither alternative should be considered acceptable.

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